



## ***Topic 2: Experiences of applying experimental design to simulation studies***

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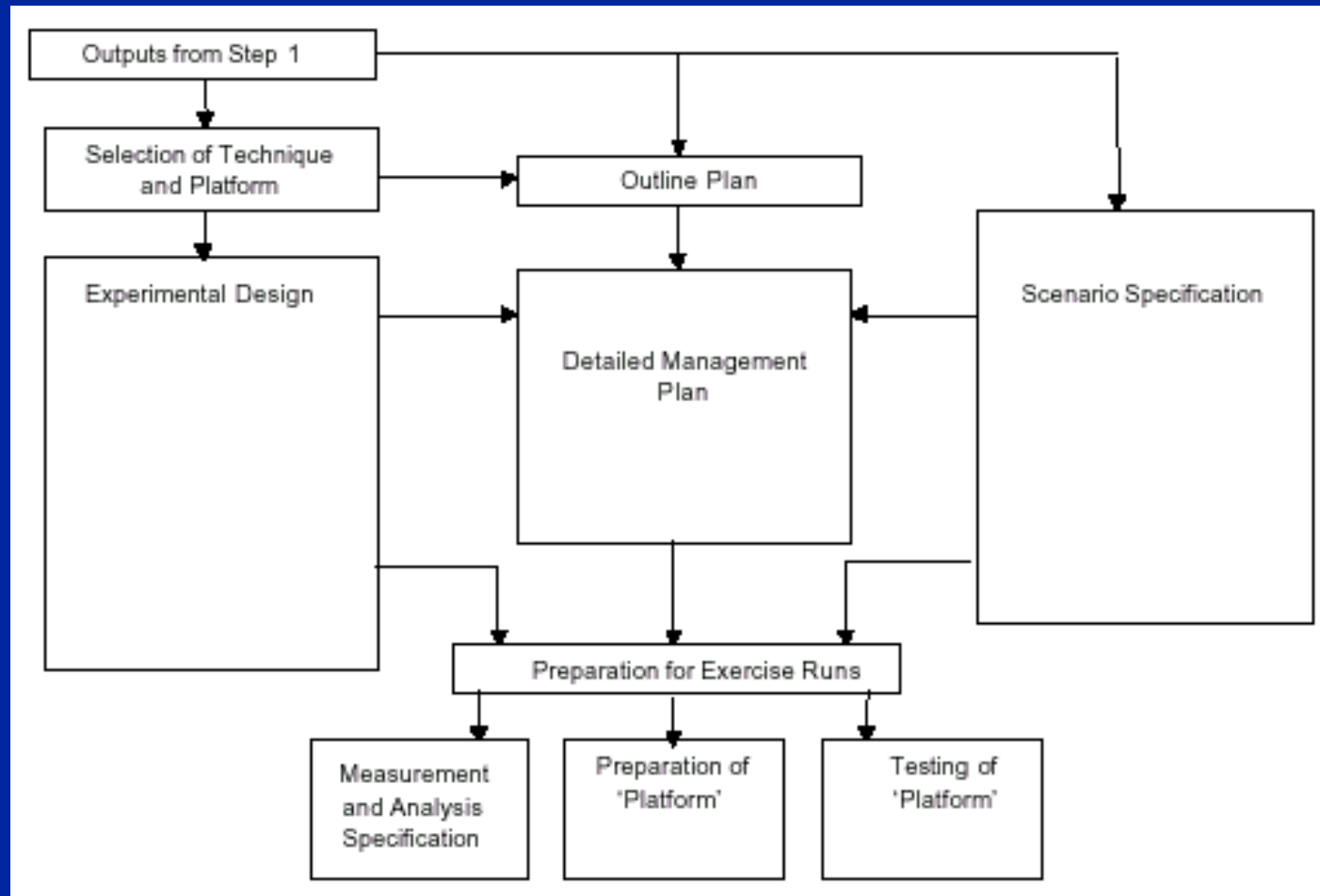
## ***MAEVA Approach (DEVAM)***

- Step 1: Define the validation aims, objectives and hypotheses
- **Step 2: Prepare the validation plan and prepare for exercise runs**
- **Step 3: Execute exercise runs and make measurements**
- Step 4: Analyse results
- Step 5: Develop conclusions and disseminate





# Process of applying Experimental Design







## ***From Aims and Objectives...***

- **Aims, Objectives, Hypotheses**
  - Understanding of ATM Problem and Concept
  - Identification of Stakeholders (Confidence)
  - What should be achieved (qualitatively and quantitatively)?
  - What should be measured (metrics)?
- **Validation Platform Requirements**
  - Scope, Resolution, Geographic Location, Time Frame
- **Selection of Validation Technique and Platform**
- **High-Level Experimental Design**





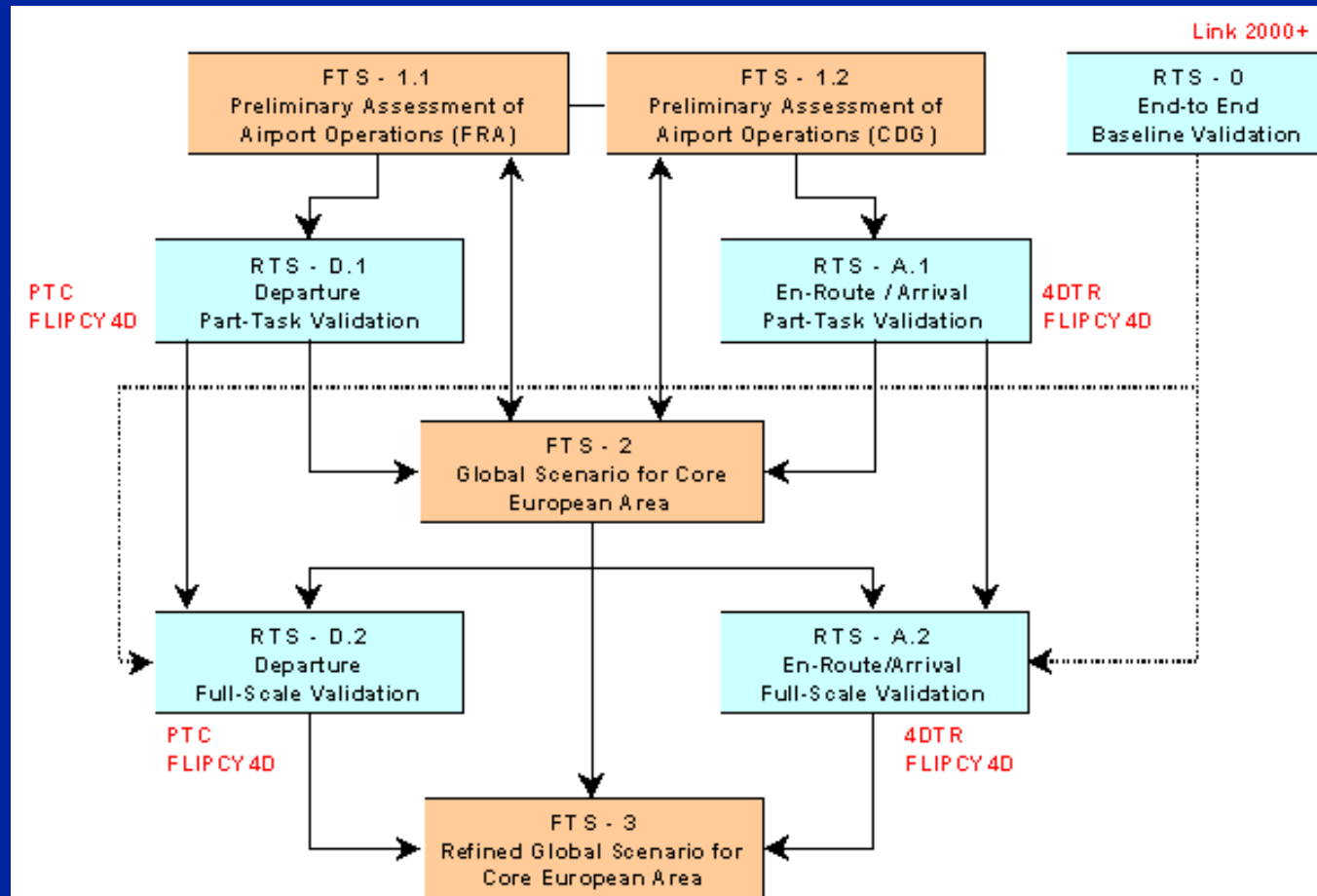
## *...to Experimental Design*

- **Experimental Design**
  - Planning of Scenarios and Resources to meet Objectives
- **Scenario Specification**
  - Baseline, Advanced Concept, Geographic Area, Time Frame, Scripting of Events, Traffic Samples, Assumptions
- **Outline Plan**
  - Summary of Simulation Runs and Measurements
- **Detailed Management Plan**
  - Scope and Timing of Simulations, Formal Reference





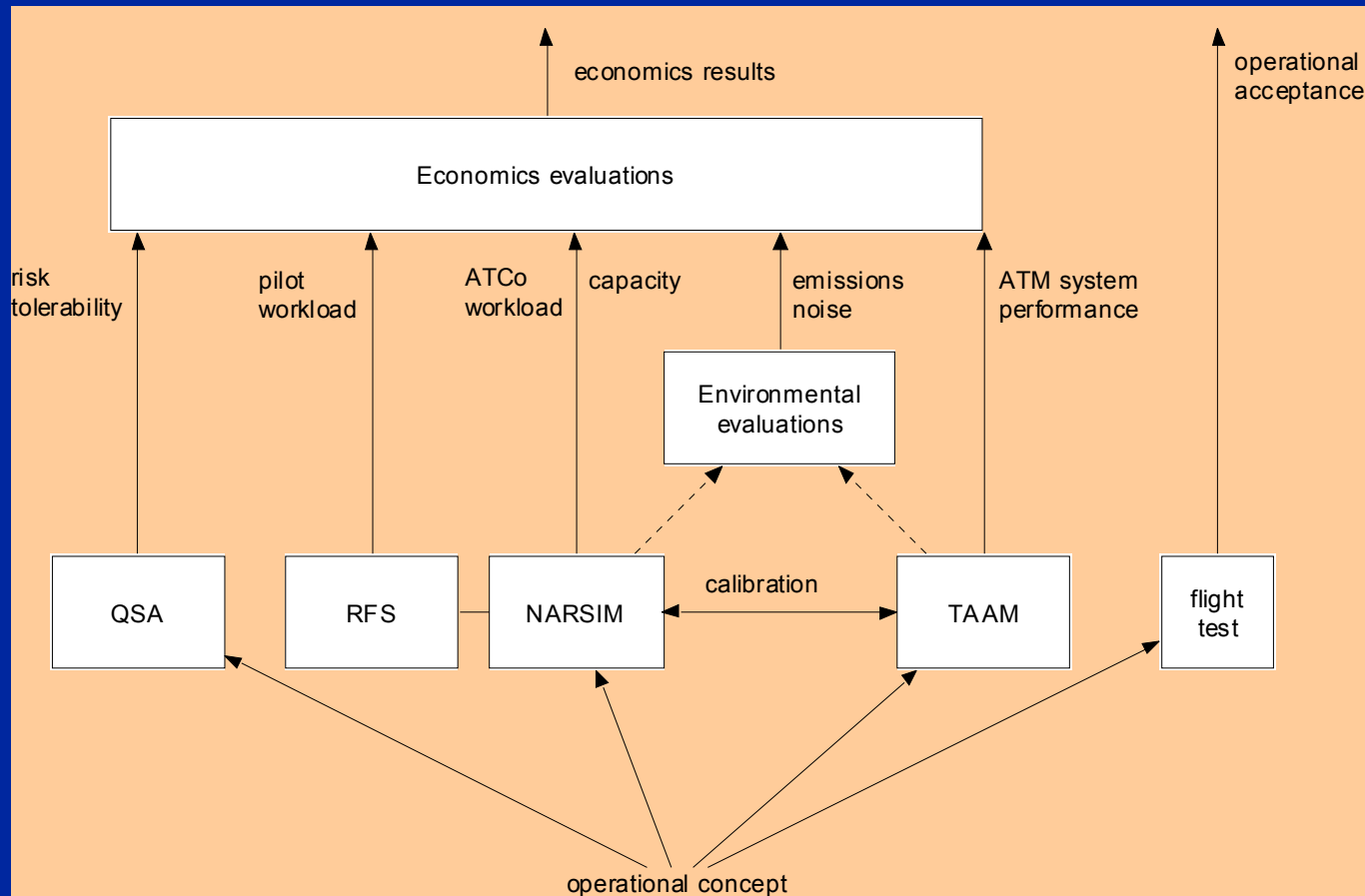
# Example: AFAS Validation Strategy







# Example: APPROVE Validation Strategy







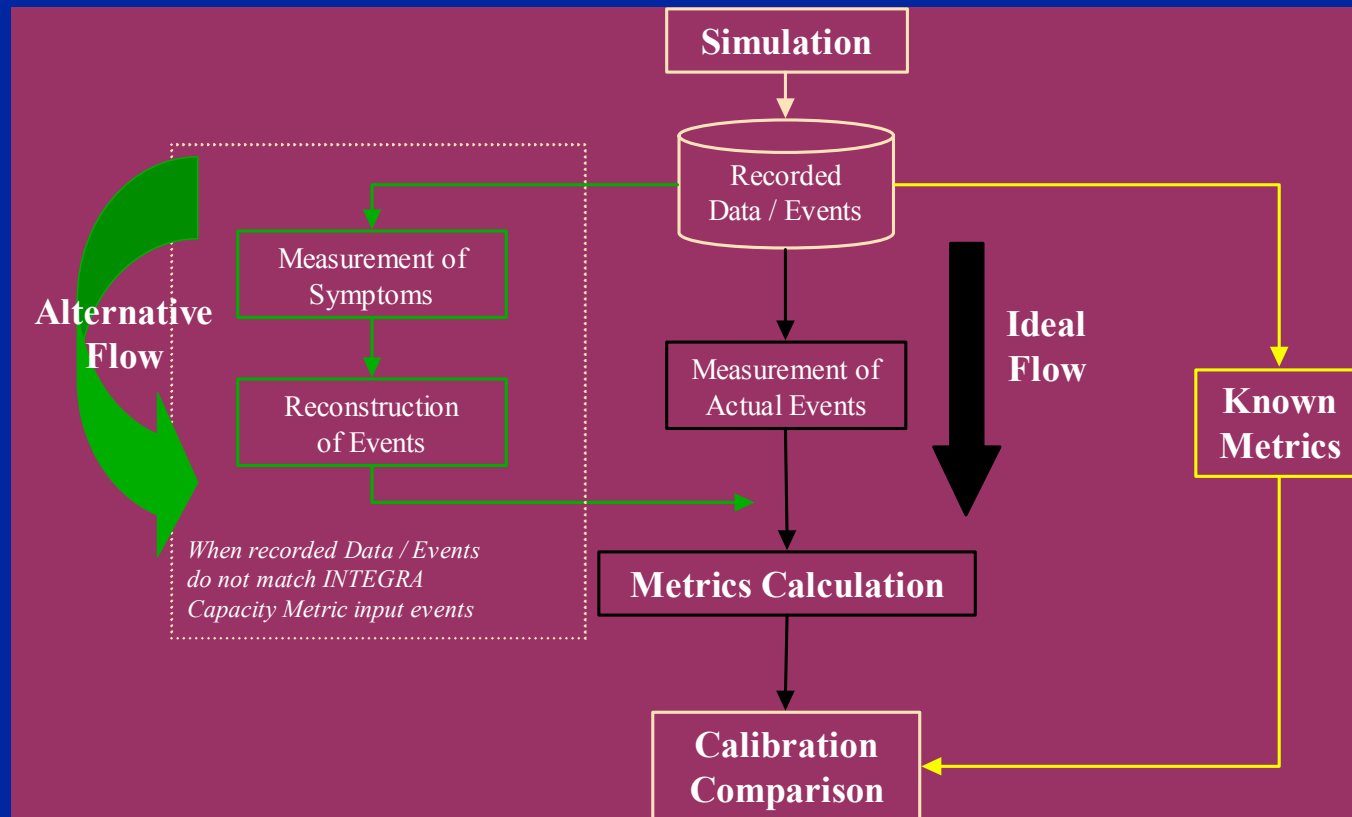
# ***Measurement and Analysis Specification***

- **Support of Planning and Execution**
- **Summary of Measurements and Data Analysis**
- **Identification of Inconsistencies**
- **Review of Design Elements**
  - Validation Aims (High Level Objectives)
  - Metrics and Measurements (Low Level Objectives and Hypotheses)
  - Data Analysis Methods (Statistical Significance)
  - Controller Requirements (Number of Controllers/Sectors)
  - Training (Level of Knowledge of Concept, Environment)





# Example: INTEGRA Measurement Analysis







# ***Prepared RT-HITL Simulation Platform***

- **Resemblance of Platform to Real-life Situation**
  - Special HMI and controller/pilot tools
  - Advanced functionality implemented
- **Data Logging and Recording**
- **Measuring Equipment**
- **Input Data available according to Scenario Specification**
- **Trained Participants and Validation Team (Observers)**





# ***Making Measurements***

- **Shakedown Trial**
  - Training, Debugging, Calibration
- **Briefing of Participants before each Simulation Run**
- **Data Collection Methods**
  - System Data, Physical Data Measurements from Participants, Subjective Data, Observation Data
- **Types of Collected Data**
  - Qualitative/Quantitative, Objective/Subjective, Intrusive/Non-intrusive, Binary/Not-binary, Nominal/Ordinal/Interval/Ratio-level





# ***Subjective Measurements***

- **Data Obtained from Participants During the Exercise**
  - ISA, SWAT, Secondary Task, Verbal Protocol
- **Data Obtained from Participants After the Exercise**
  - Questionnaires, Self Confrontation, Interview, Verbal Protocol, Brainstorming
- **Data Types**
  - Descriptions and Explanations, Tiredness, Stress, Workload, Usability, Situation Awareness, Acceptability





# ***Objective Measurements***

- **Data Measured by Automated System**
  - Logging of Aircraft Parameters (Simulated or Real A/C), Radar Tracks, R/T, Flight Plan Data, Number of A/C in Sector, Number of Clearances
- **Physical Data Measured**
  - Physiological Measurements (Heart Rate, Brain Activity, Muscle Tension, Respiration, Skin Resistance, Pupil Changes, Biochemical Indicators) and Physical Movements (Eye Movement and Head Movement)





# ***Observations***

- **Direct or Assisted Observations**
  - Learning Time, Number of Errors or Help Requests, Verbal or Gestured Communication between Participants, Negotiation or Action Time
- **Use of Recording Facilities**
  - Video Recording
  - Audio Recording
  - Records taken by Validation Team Observers





# ***Conclusions and Recommendations (Experiences and Lessons Learned)***

- **Good Understanding of ATM Concept Manifested in Operational Scenario Definition**
- **Unambiguous Determination of Validation Aims and Objectives**
- **Careful Selection of Hypotheses**
- **Careful Selection of Validation Platforms and Writing of an Outline Plan (Interrelations between Discrete Simulation Runs at Different Platforms)**
- **Good Match between Measurements and Analysis Method (MAS)**
- **Good Preparation of Simulation Participants and Observers**
- **Emergency Plan for Failing Systems**